

THE WEATHER AND CIRCULATION OF DECEMBER 1954¹

A Month With a Cyclonic Polar Vortex and Fast Westerlies in High Latitudes

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SOME FEATURES OF THE HEMISPHERIC CIRCULATION

During December abnormally strong westerlies prevailed at high latitudes, but at 700 mb. wind speeds were subnormal at middle latitudes (fig. 1). This condition was associated with an elongated area of below normal 700-mb. heights extending from the Gulf of Alaska across the Polar basin to Greenland, and then southeastward into Europe, with the greatest negative anomaly (−440 feet) located in a closed cyclonic vortex over the American Arctic (fig. 2). This area was surrounded by positive height anomalies which were for the most part centered north of 45° N. latitude.

The most intense of these positive anomalies was situated in a strong ridge over northern Siberia, where heights were 490 feet above normal and sea level pressures were 18 mb. above normal. On the western side of this ridge anomalous flow from the south was strong, as indicated by the large anomaly gradient between Scandinavia and north-central Siberia in figure 2. This flow was instrumental in transporting considerable warm air from the vicinity of the Black Sea northward into the Russian Arctic, resulting in a thickness anomaly (1,000–700 mb.) of +260 feet (not shown) northeast of Novaya Zemlya. This warm air interacted with colder air in the polar regions, resulting in frequent cyclonic activity and large values of interdiurnal height variability in a belt extending from northern Scandinavia eastward along the northern coastal region of Eurasia (fig. 3). Many of these storms appear to have been carried eastward around the Pole into the American Arctic, where they contributed to the maintenance of large negative anomalies in the polar vortex. Similarly, strong westerly flow in western and northern Canada was accompanied by considerable cyclonic activity (Chart X) and contributed to lower heights in the polar regions.

Another region where heights of the 700-mb. surface were well below normal was the Northeast Atlantic, where an anomaly of −400 feet was present. Large values of cyclonic relative vorticity also prevailed in this area (fig. 4) which was located to the north of a belt of unusually strong westerlies (fig. 1). The storminess in

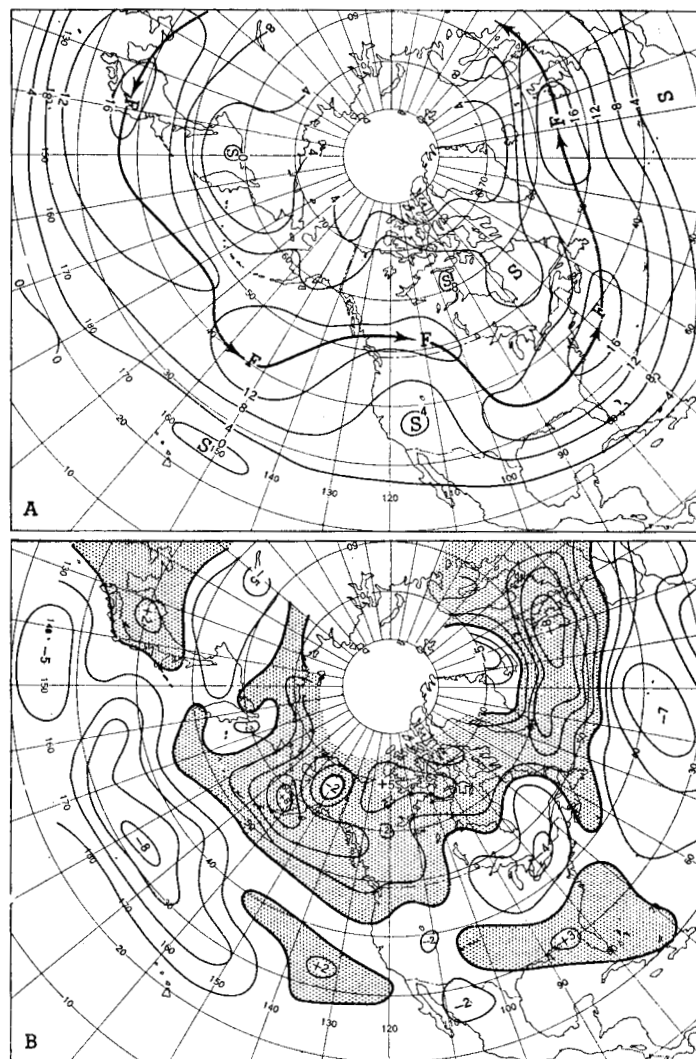


FIGURE 1.—(A) Mean 700-mb. isotachs and (B) departure from normal wind speed (both in m. p. s.) for December 1954. Solid arrow indicates position of maximum average westerlies. Wind speeds were as high as 8 m. p. s. above normal over the Alaskan Peninsula and the British Isles.

this current was particularly intense, and caused heavy rains, floods, gales, and high tides in Great Britain, the Low Countries, France, and Germany. Many of these storms subsequently moved northeastward and contributed in part to the maintenance of the deep polar vortex.

¹ See Charts I–XV following p. 390 for analyzed climatological data for the month.

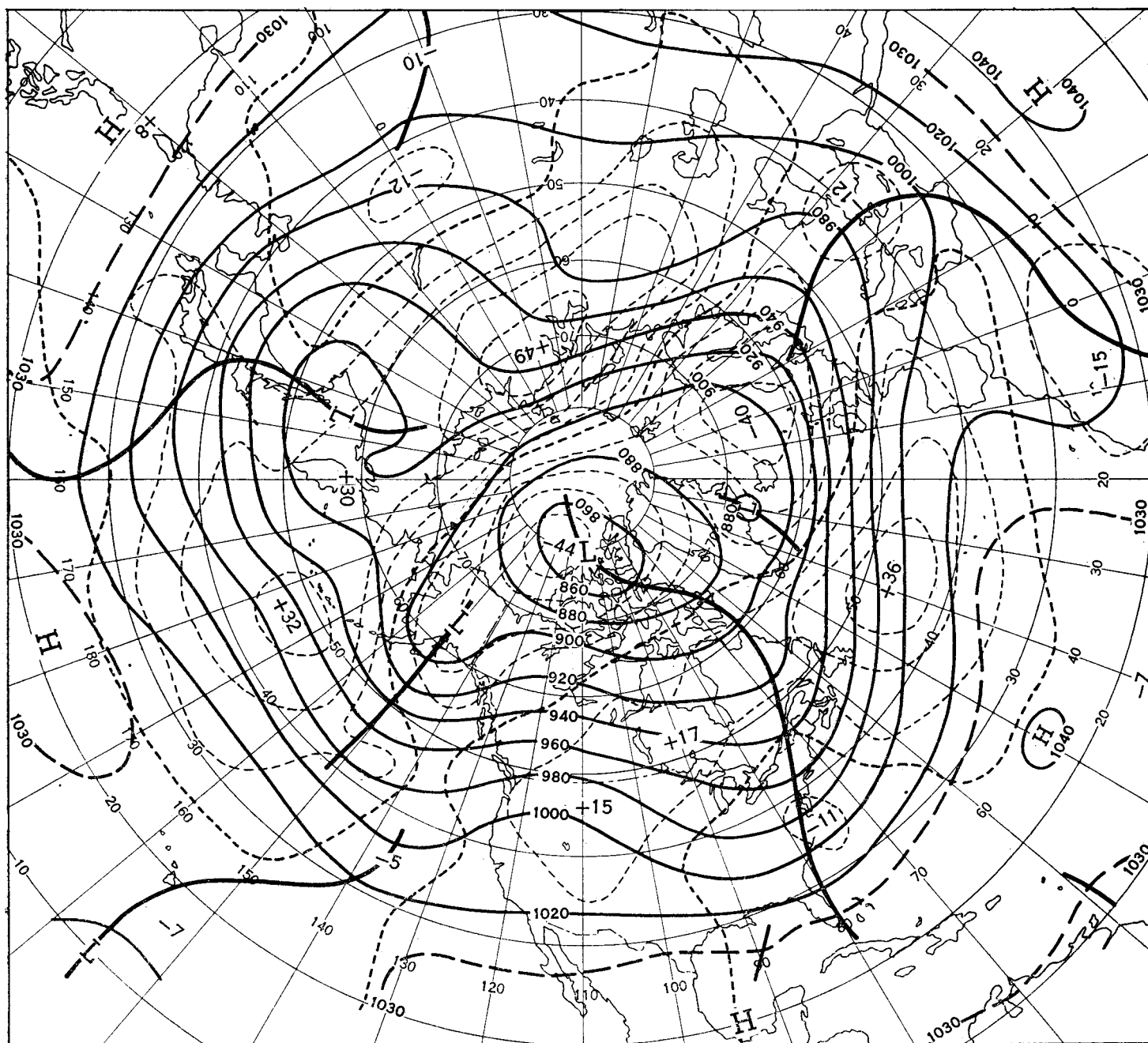


FIGURE 2.—Mean 700-mb. height contours and departures from normal (both in tens of feet) for November 30–December 29, 1954. An extensive area of below normal heights accompanied a closed cyclonic vortex in the Arctic.

Despite the prevalence of large positive anomalies over central portions of the Atlantic and Pacific, fast westerlies in these regions were accompanied by large day-to-day fluctuations in 700-mb. height (fig. 3), indicating that these anomalies were reinforced by frequent perturbations from upstream. Maximum values of interdiurnal variability, however, were associated with large values of cyclonic vorticity (fig. 4). In general the axis of maximum interdiurnal height change was a little to the south of the channel of maximum cyclonic vorticity and a little north of the axis of maximum wind speed, as noted by Klein [1] in an early article in this series.

Over the North American continent heights averaged below normal in northwestern and southeastern sectors and above normal over the remainder. These anomalies were associated with troughs over Alaska and the East and a ridge along the Rockies. The amplitude of this wave pattern was greatest (about 11° of latitude) across the United States and least (about 7° of latitude) in northern Canada.

THE WEATHER OVER THE UNITED STATES

Accompanying the below normal heights and sea level pressures over Alaska and the fast westerly flow across

Canada, surface temperatures averaged above normal throughout the Plains States, especially in the north where departures as great as 12° above normal were reported (Chart I-B). Warmest temperature departures were located where the strongest winds at 700 mb. crossed the Continental Divide, where foehn warming was at a maximum. Temperatures were also above normal in New England as a consequence of anomalous southeasterly flow of air from the Atlantic.

Unseasonably cool weather in the Southeast was accompanied by below normal heights and northerly anomalous flow. Temperatures averaged as much as 4° below normal in Florida as frequent cold outbreaks with below freezing temperatures penetrated the State. Tallahassee, for example, experienced 11 days on which the minimum temperature fell below freezing.

Below normal temperatures prevailed in the Southwest, largely due to the prevalence of an abnormally strong sea level High over the Great Basin (Chart XI).² Actually the 1,000–700-mb. thickness anomaly was positive over this region, implying that the surface must have been covered by a shallow layer of cold air with warmer air above. As is typical in such a situation [2, 3], fog and cloudiness were frequent (Charts VI and VII) particularly in the Valley of California, and consequently the daily range in temperature was small. Thus cold air, because of its extreme stability, remained in the valleys for long periods until it could be scoured out by strong westerlies.

Precipitation (Chart III) showed a tendency to exceed normal wherever the relative vorticity at 700 mb. was cyclonic, and to be deficient where it was anticyclonic. Thus, amounts in excess of normal occurred in the east-central and northeastern parts of the country, as well as in California, while amounts were light in much of the Plains States, Gulf States, and Southwest. Large values of cyclonic vorticity in the eastern United States trough extended far west of the trough line, while anticyclonic vorticity prevailed in the western part of the country in conjunction with the Basin High and ridge aloft. The warm, sunny, and dry weather that resulted over the Great Plains aggravated the drought condition by depleting further the existing soil moisture and prepared the way for the soil blowing, which occurred about the middle of the month in parts of the Central and Southern Plains.

FURTHER COMMENTS ON THE POLAR VORTEX

The existence of an abnormally intense polar vortex has been one of the outstanding, though puzzling, features of the general circulation of the year 1954 [4] and especially of the months of February [5] and November [6]. It may be associated with the warming trend which has taken place at high latitudes during this century. According to Mather [7] this warming has been accompanied by decreased pressures in the polar region, a more intense Siberian High displaced northward, and stronger southerly

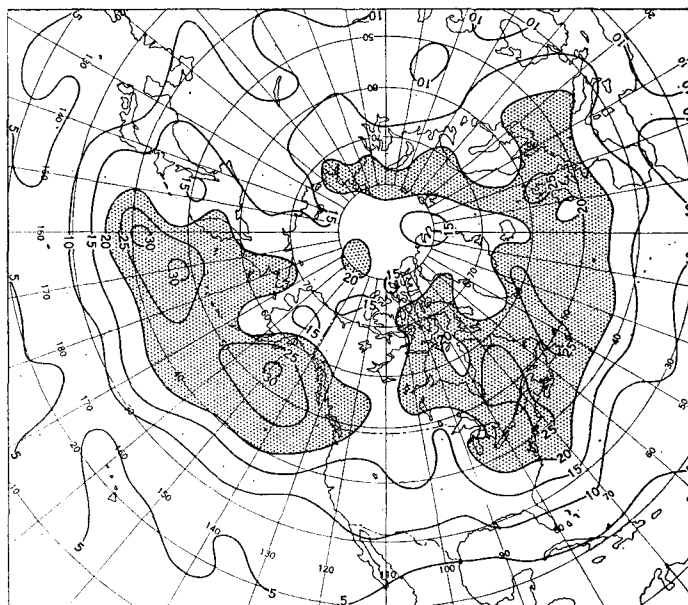


FIGURE 3.—Average values of interdiurnal height variability at 700 mb. during December 1954 (feet/day). Largest day-to-day changes occurred in the westerlies over oceanic areas just north of the axis of strongest wind speed.

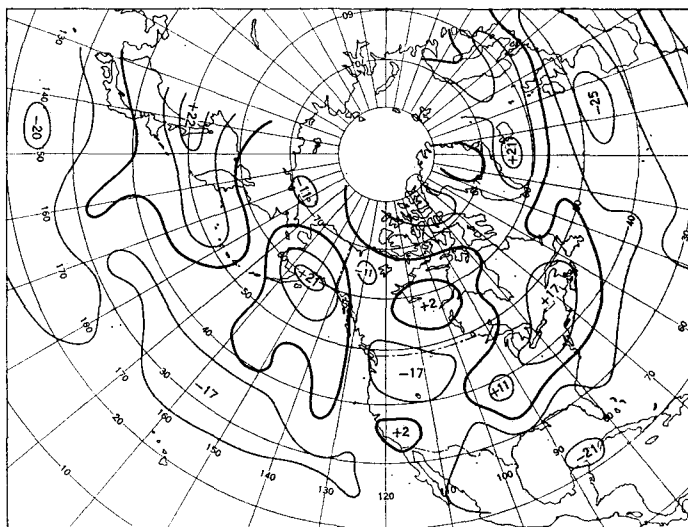


FIGURE 4.—Vertical component of mean relative geostrophic vorticity at 700 mb. for the 30-day period November 30–December 29, 1954, in units of 10^6 sec^{-1} . Large values of anticyclonic vorticity over the western part of the United States were indicative of low precipitation amounts during the month.

flow across Europe. As indicated earlier these conditions were also present this month; but this in itself naturally does not necessarily imply a long period trend.

According to Dorsey [8], low pressure and storminess are far from being a recent phenomenon in the Arctic. He points out that in the past when Arctic data were meager, imaginative analysts tended to draw pressures too high because of the belief that the Arctic must be dominated by high pressure. As the number of Arctic observations increases, there are more reports of lower pressures, and thus it is possible to obtain an erroneous impression of a secular trend. From this one would conclude that data currently available are quite inadequate to establish the reality of such a trend in Arctic pressures.

²For a study of this anticyclone see article by Ross and Vederman in this issue.

REFERENCES

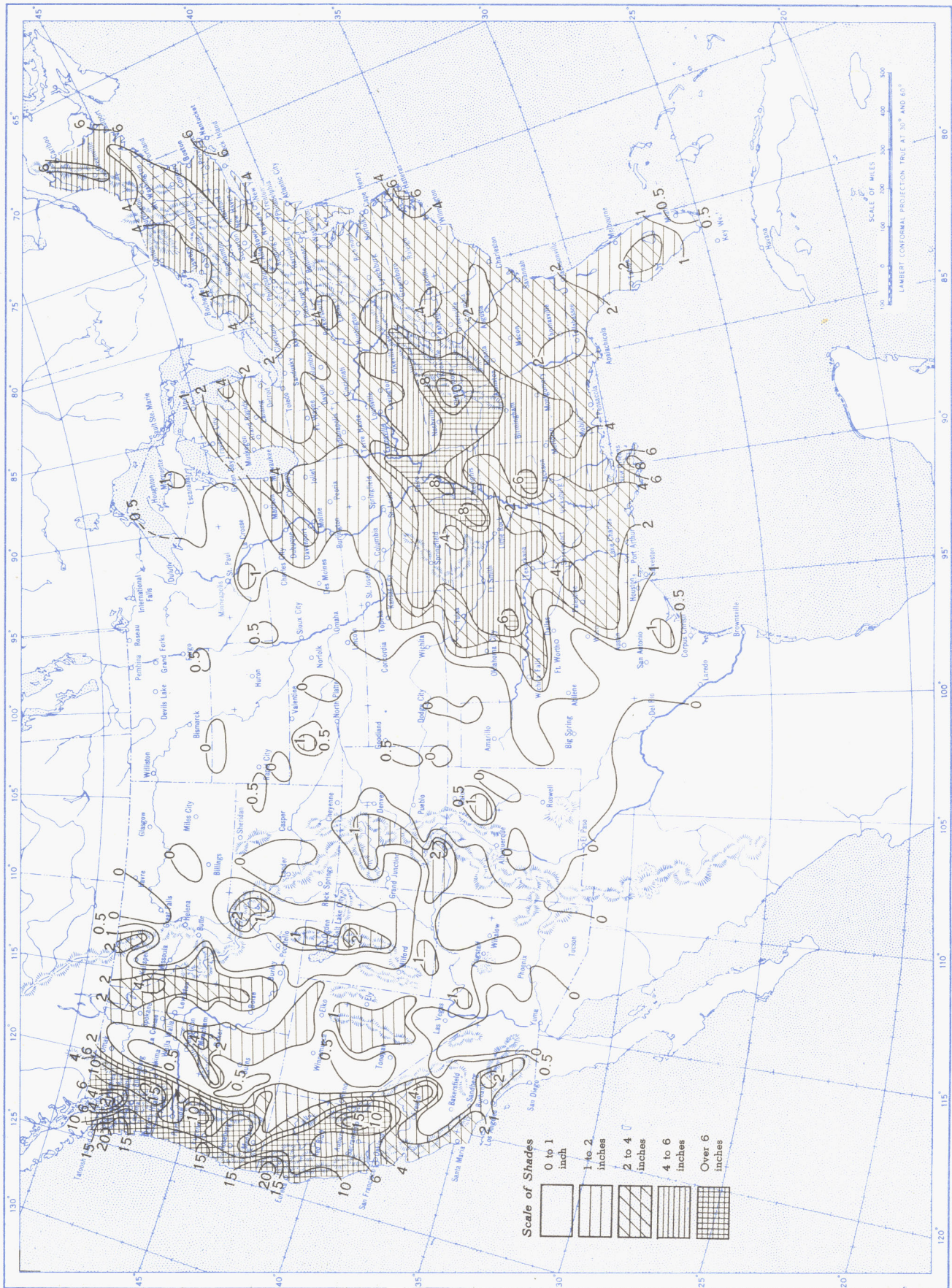
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2. A. B. Carpenter, "Record November Fog Preceding Phenomenal Winter of 1933-34 in the Pacific Northwest," *Monthly Weather Review*, vol. 62, No. 11, November 1934, pp. 404-407.
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7. R. J. Mather, "The Present Climatic Fluctuation and Its Bearing on a Reconstruction of Pleistocene Climatic Conditions," *Tellus*, vol. 6, No. 3, August 1954, pp. 287-301.
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Chart I. A. Average Temperature ($^{\circ}\text{F.}$) at Surface, December 1954.B. Departure of Average Temperature from Normal ($^{\circ}\text{F.}$), December 1954.

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

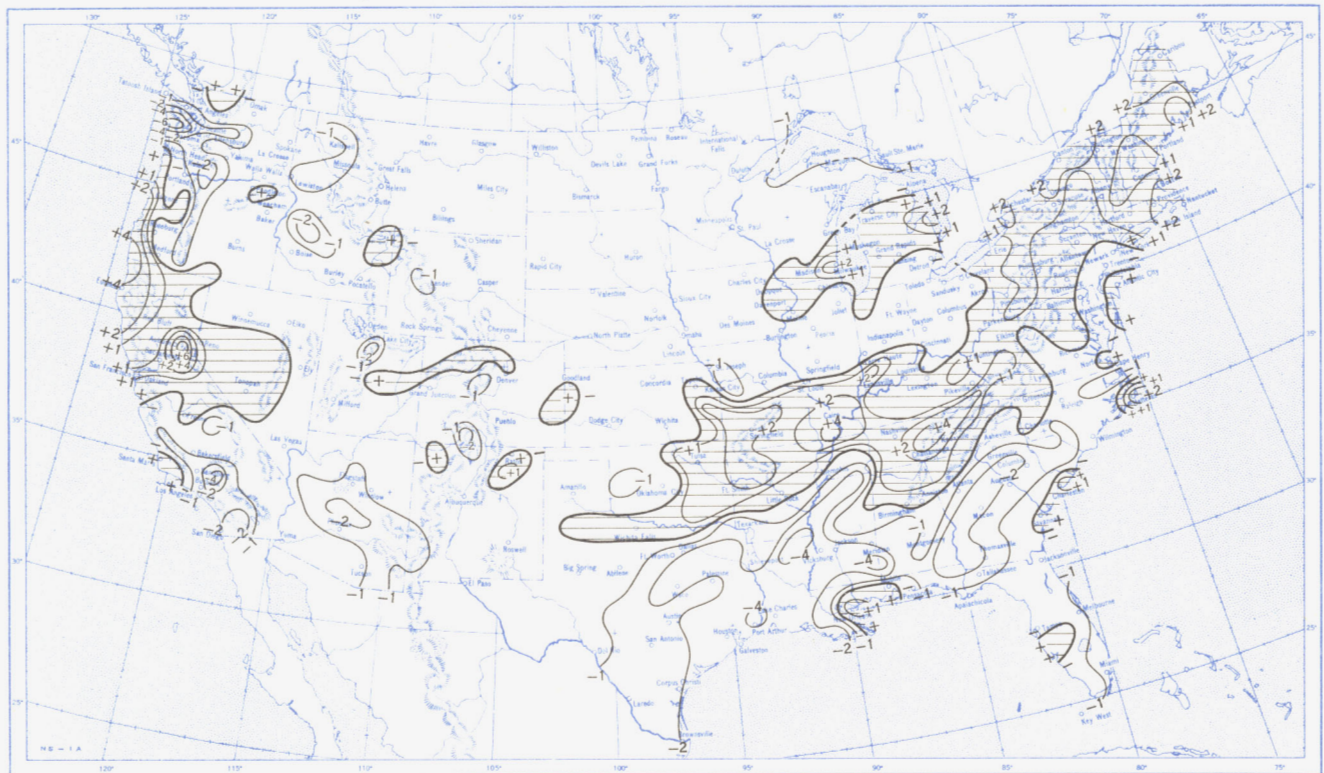
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), December 1954.

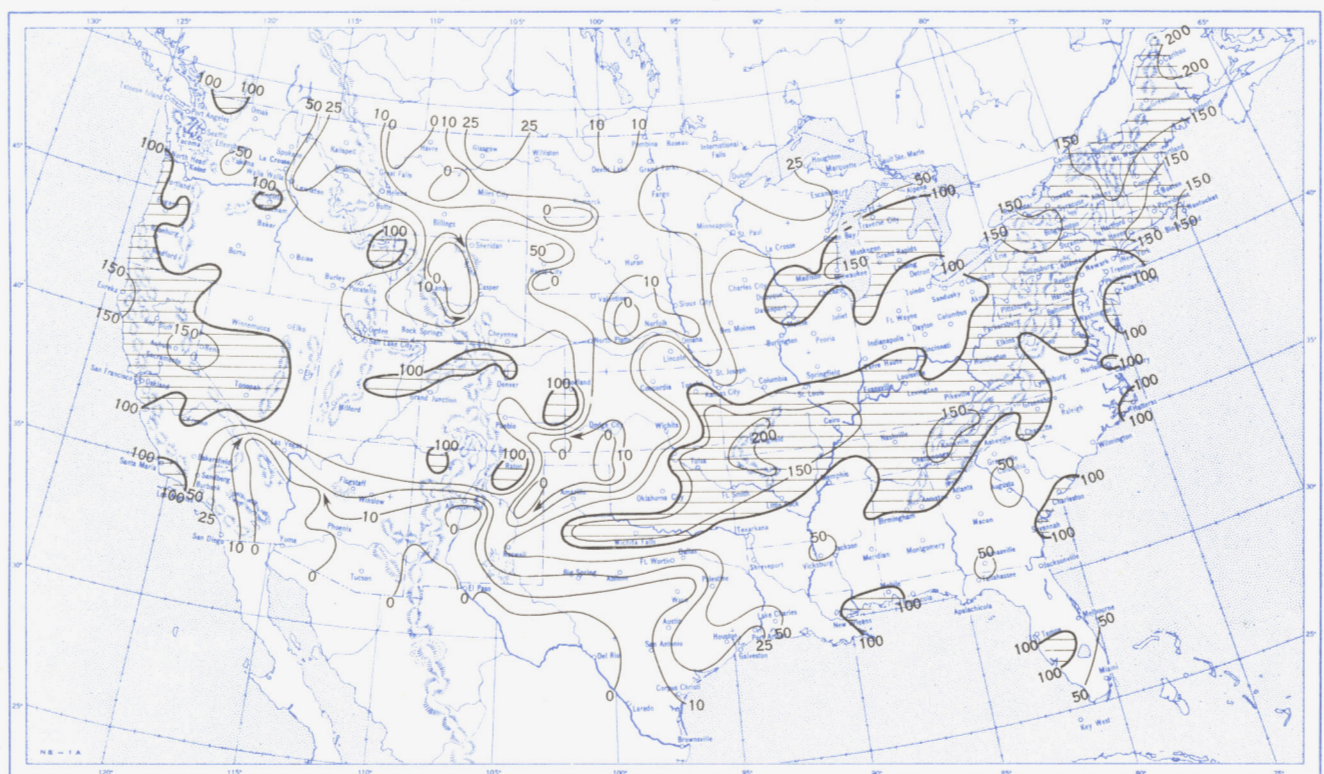


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), December 1954.

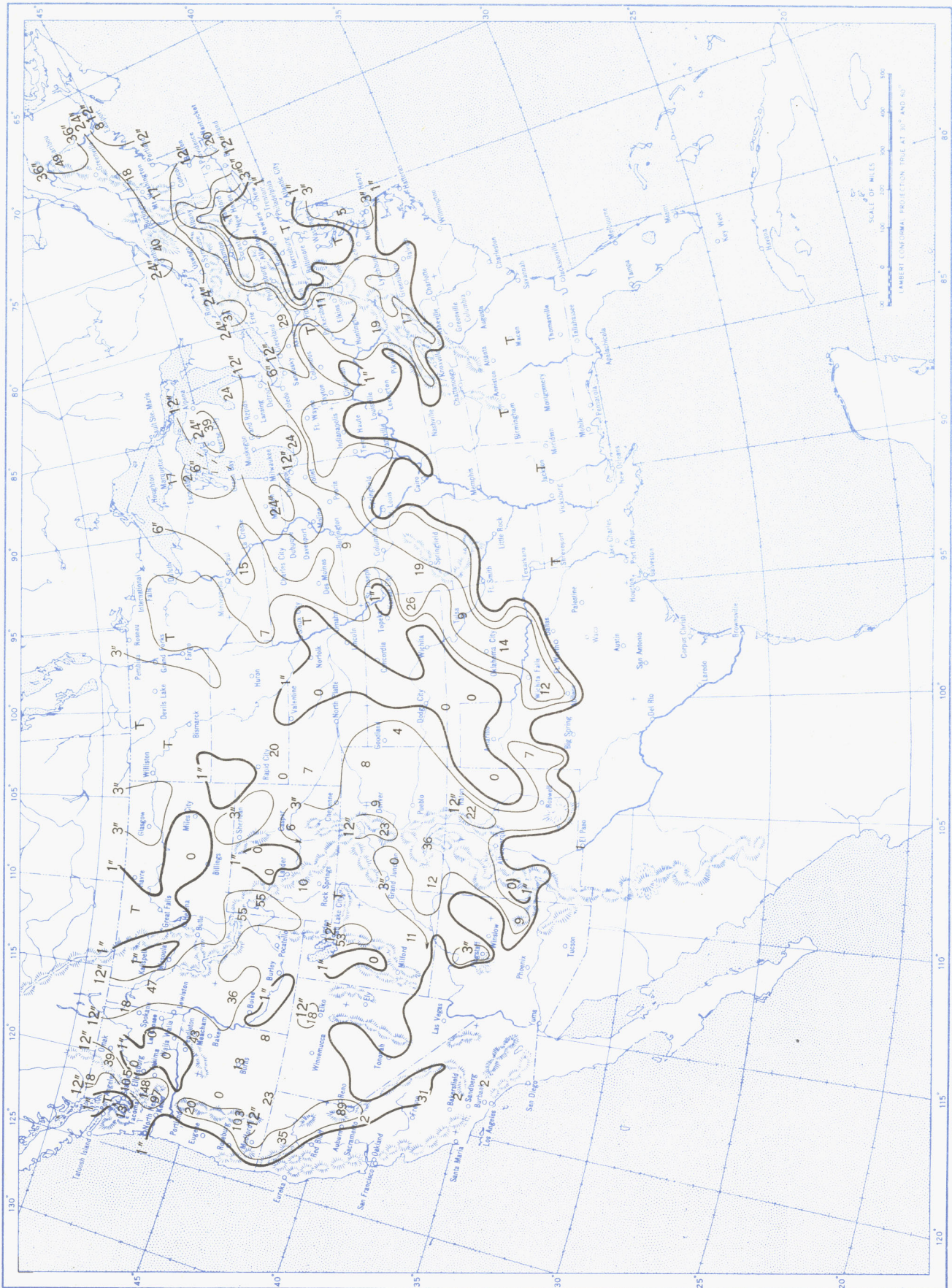


B. Percentage of Normal Precipitation, December 1954.



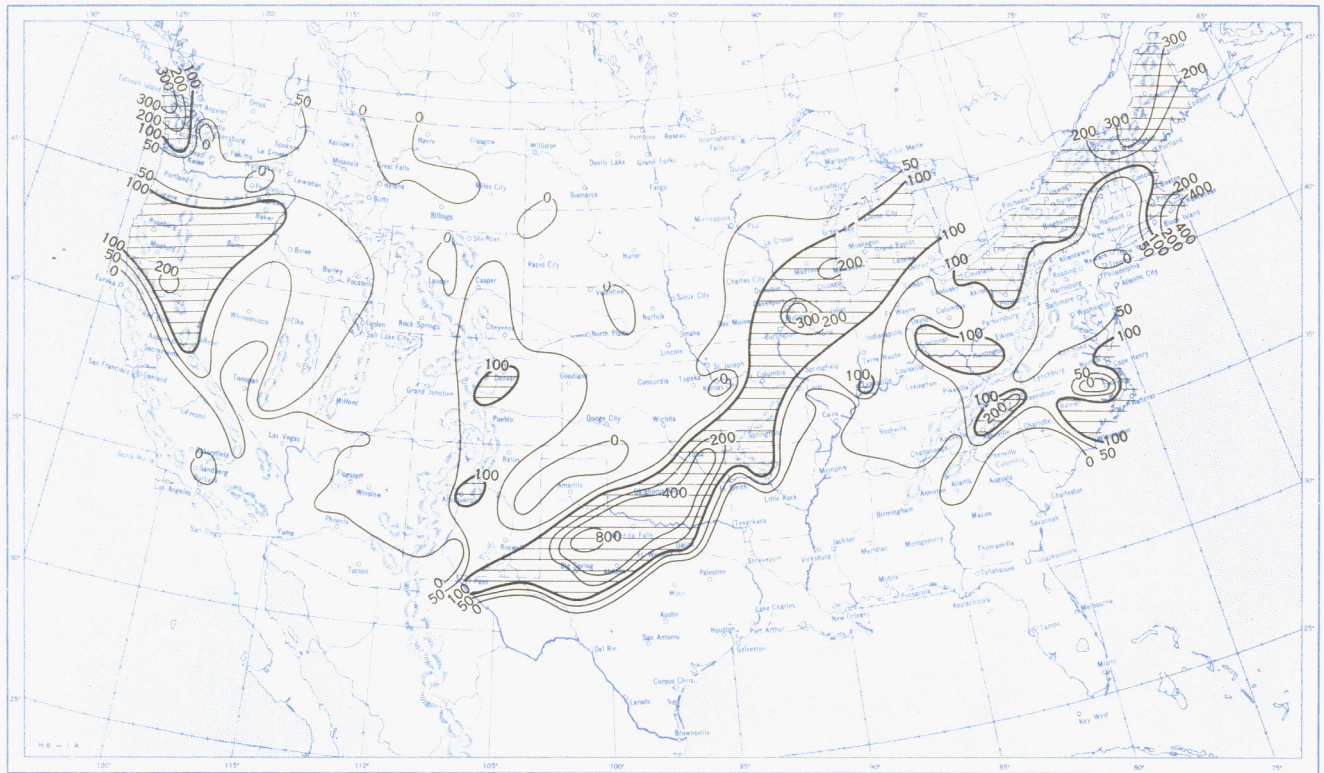
Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart IV. Total Snowfall (Inches), December 1954.

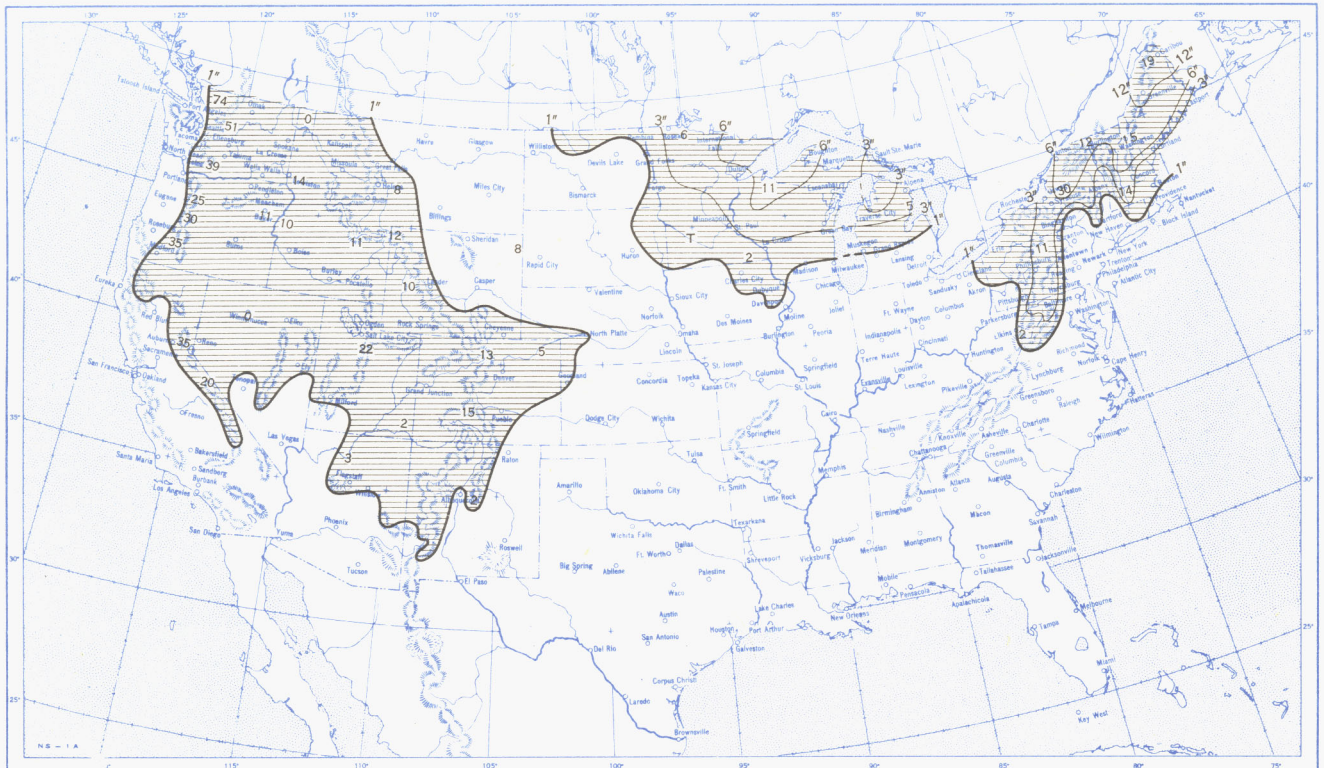


This is the total of unmelted snowfall recorded during the month at Weather Bureau and cooperative stations. This chart and Chart V are published only for the months of November through April although of course there is some snow at higher elevations, particularly in the far West, earlier and later in the year.

Chart V. A. Percentage of Normal Snowfall, December 1954.

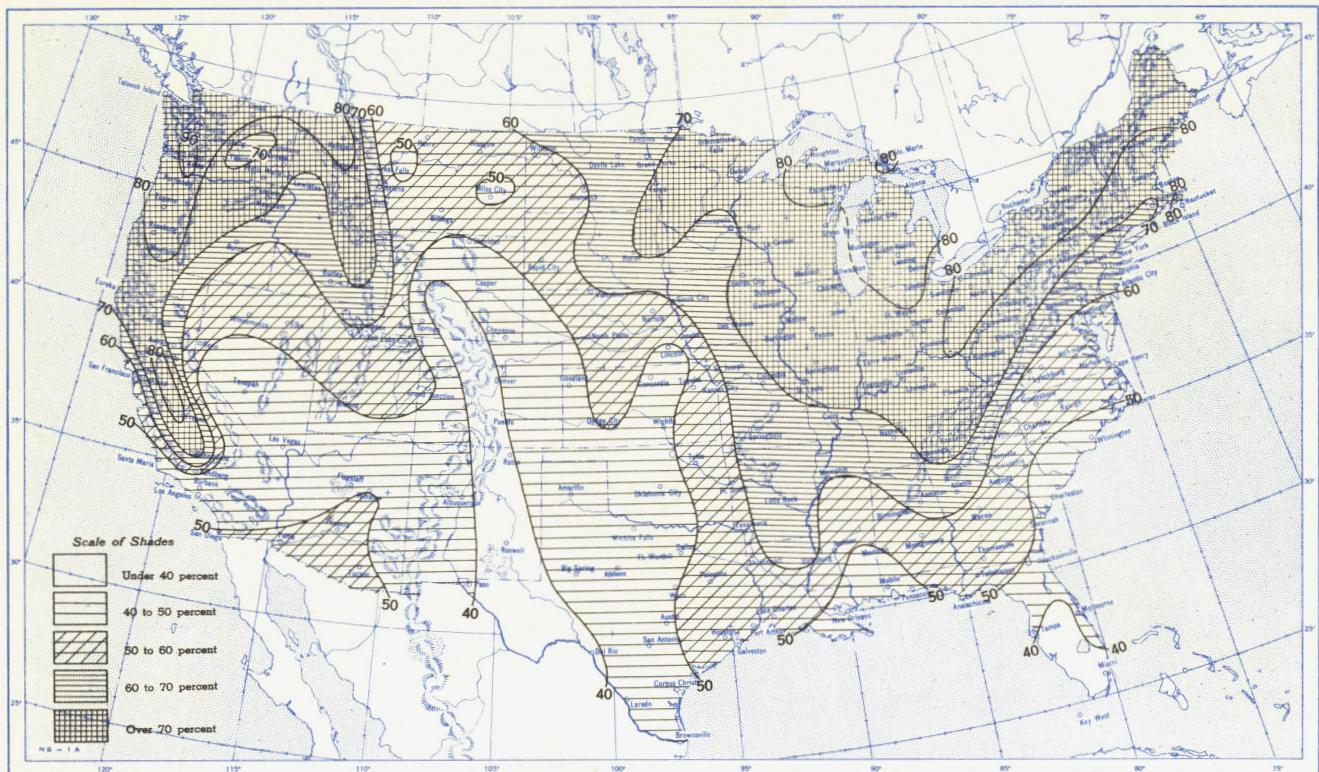


B. Depth of Snow on Ground (Inches). 7:30 a. m. E. S. T., December 28, 1954.

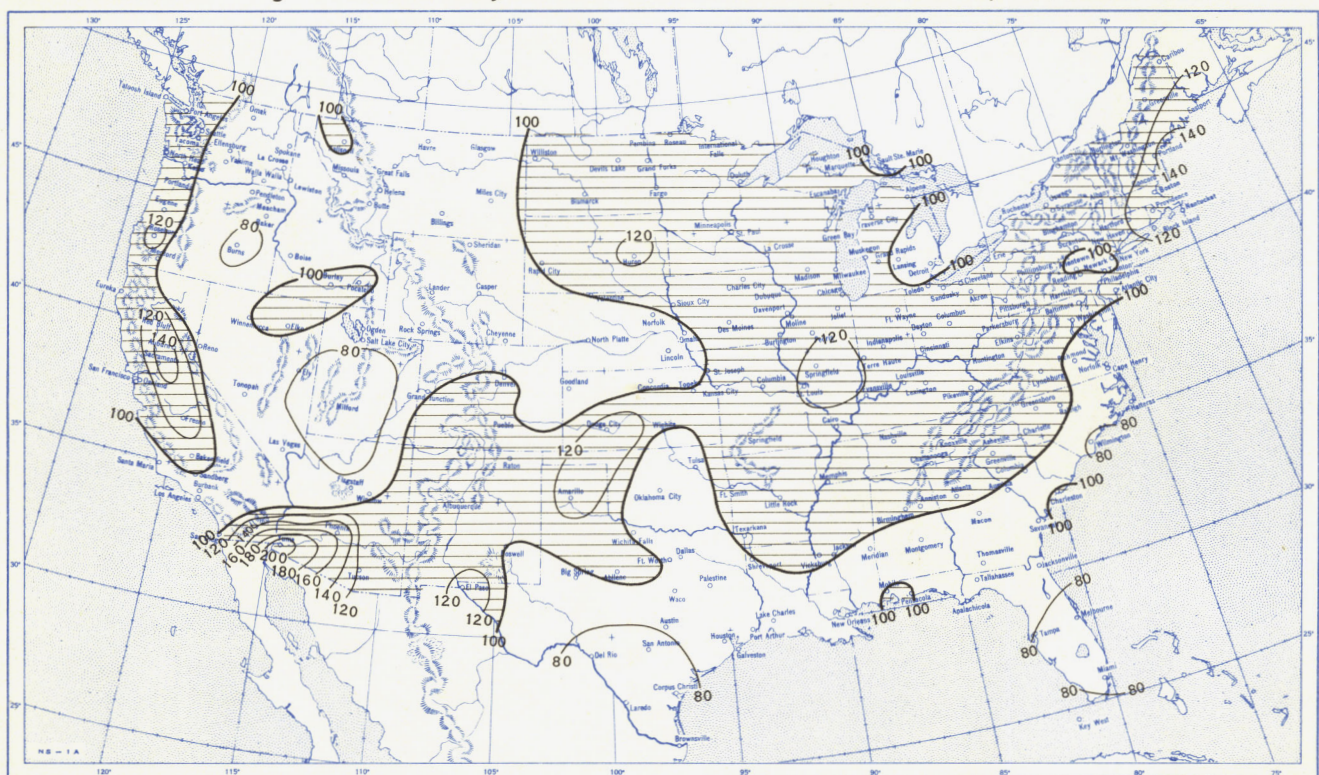


A. Amount of normal monthly snowfall is computed for Weather Bureau stations having at least 10 years of record.
 B. Shows depth currently on ground at 7:30 a. m. E. S. T., of the Tuesday nearest the end of the month. It is based on reports from Weather Bureau and cooperative stations. Dashed line shows greatest southern extent of snowcover during month.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, December 1954.

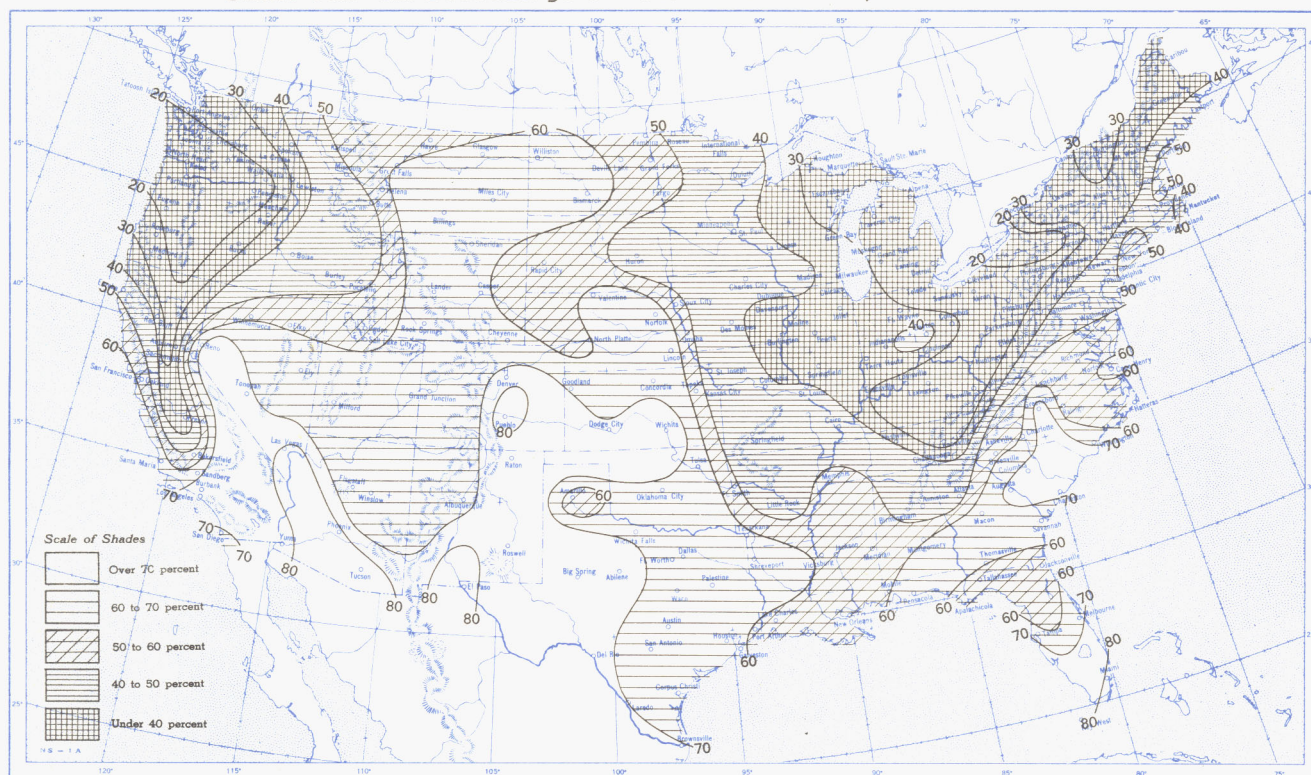


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, December 1954.

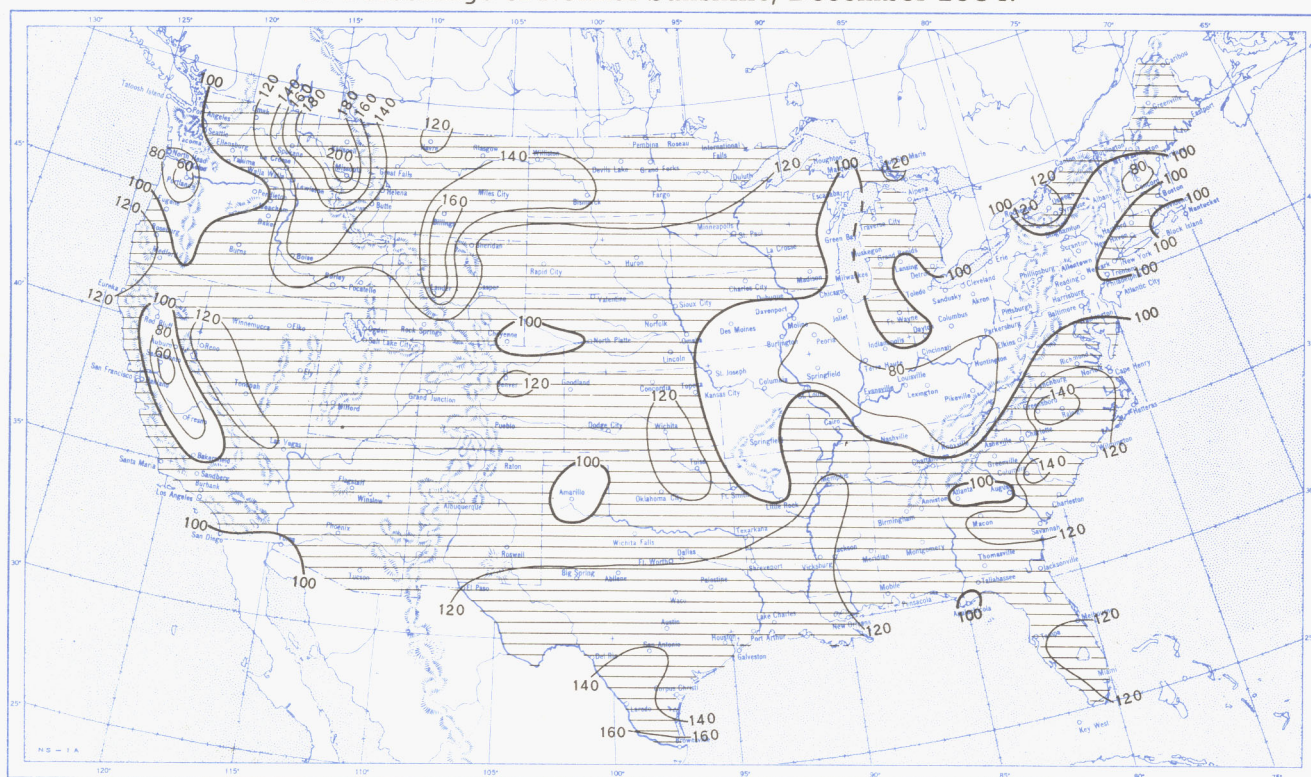


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, December 1954.



B. Percentage of Normal Sunshine, December 1954.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, December 1954. Inset: Percentage of Normal Average Daily Solar Radiation, December 1954.

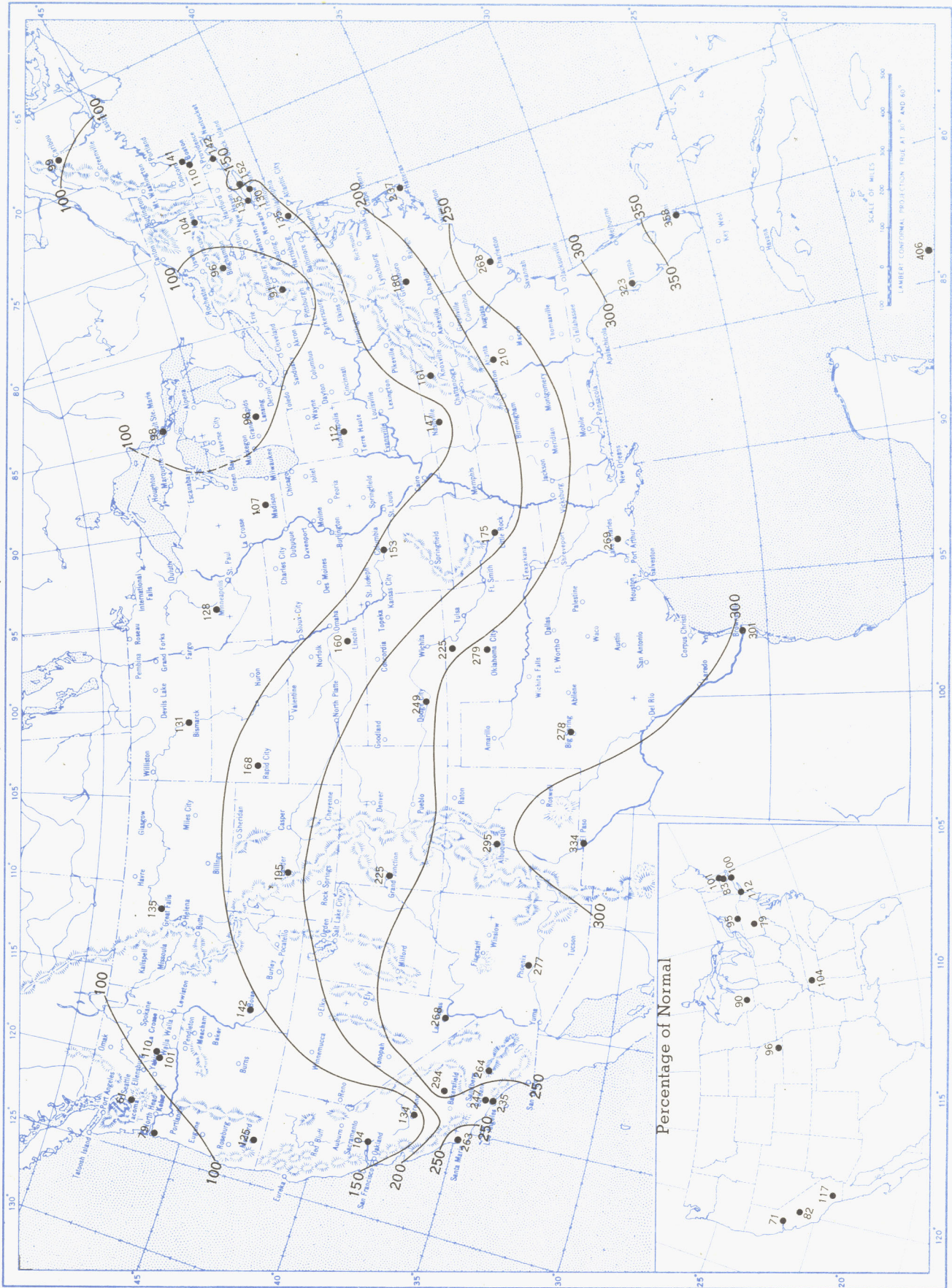
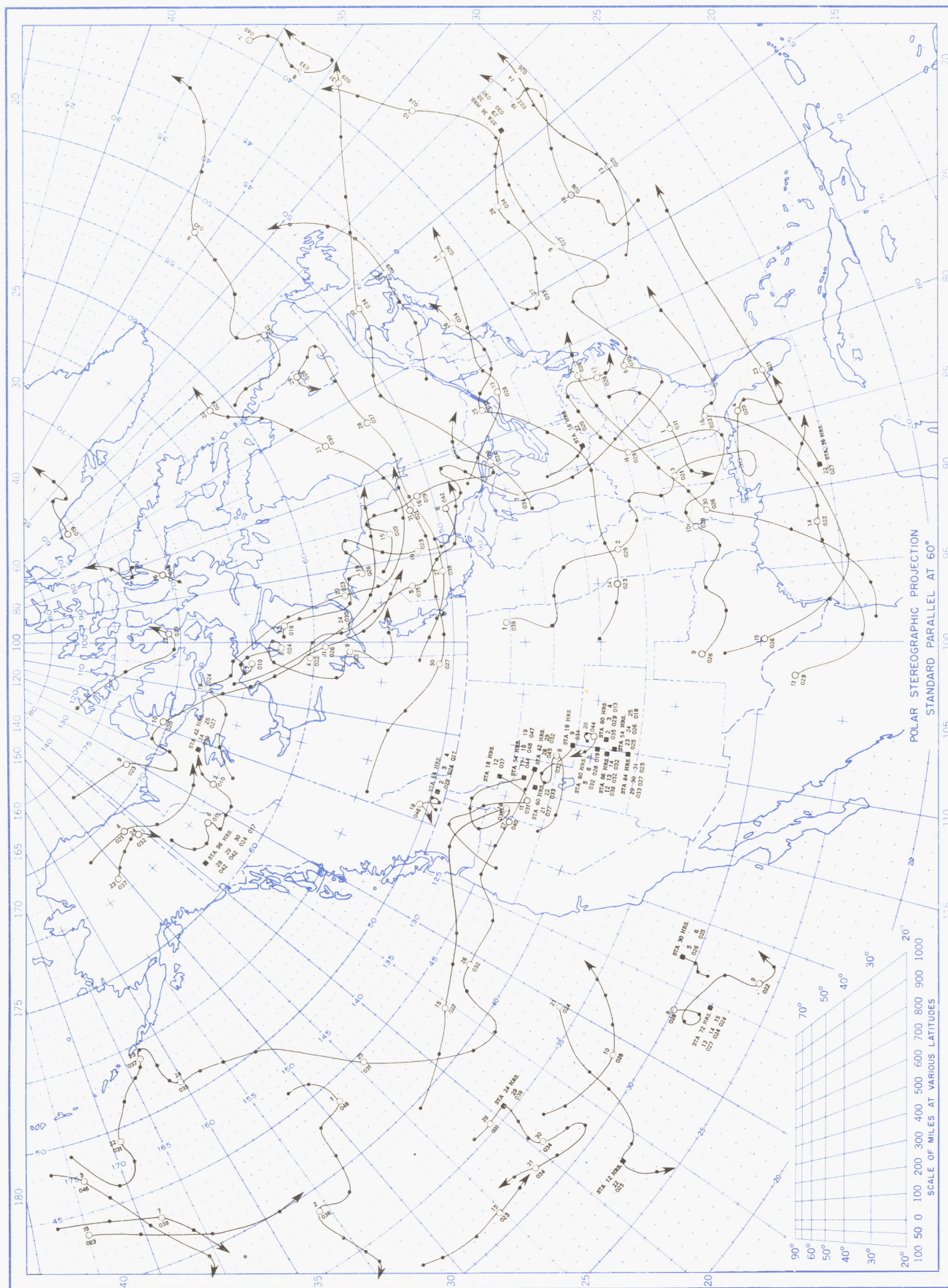


Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.⁻²). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, December 1954.



Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Squares indicate intervening 6-hourly positions. Dots indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, December 1954.

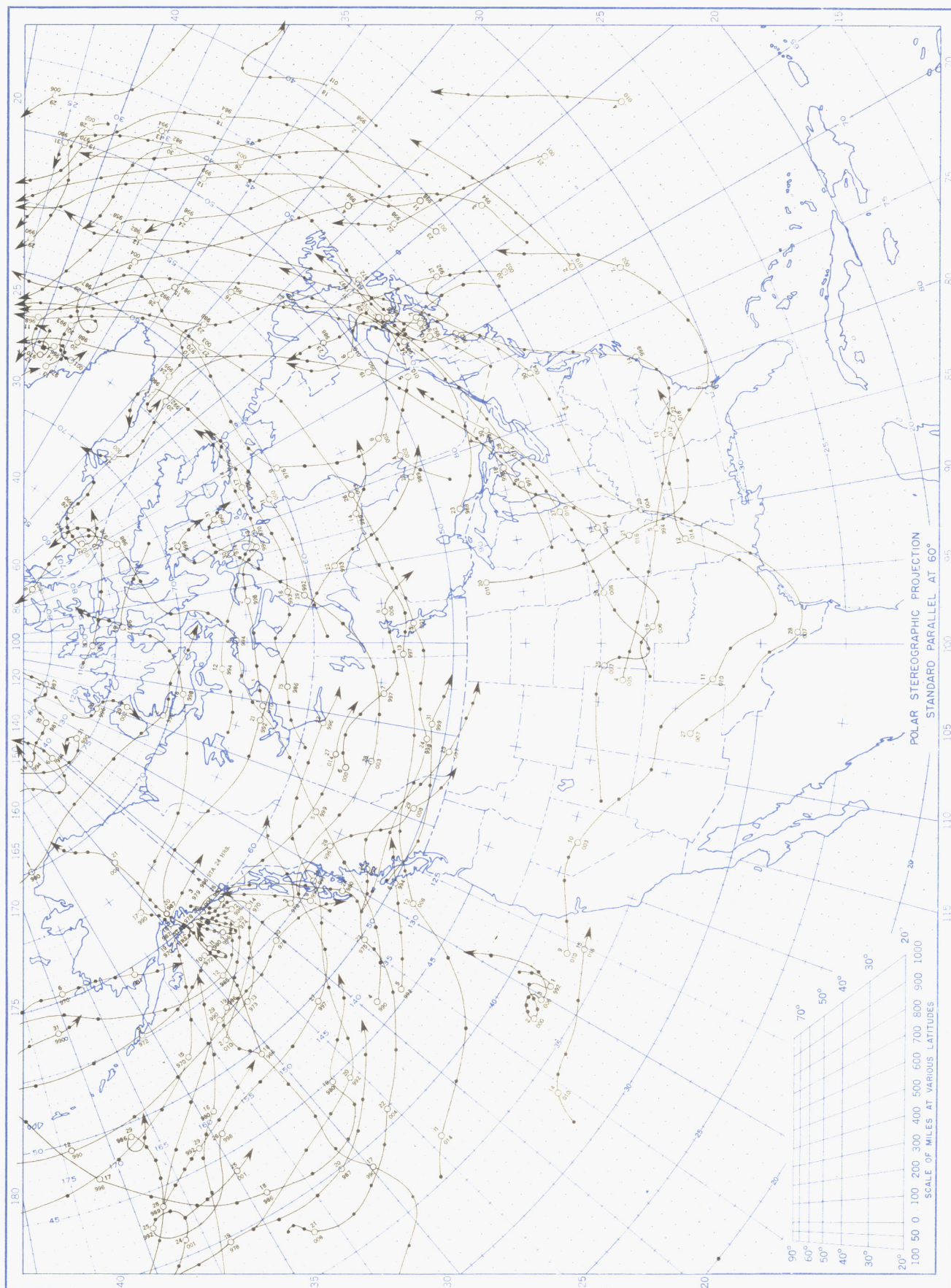
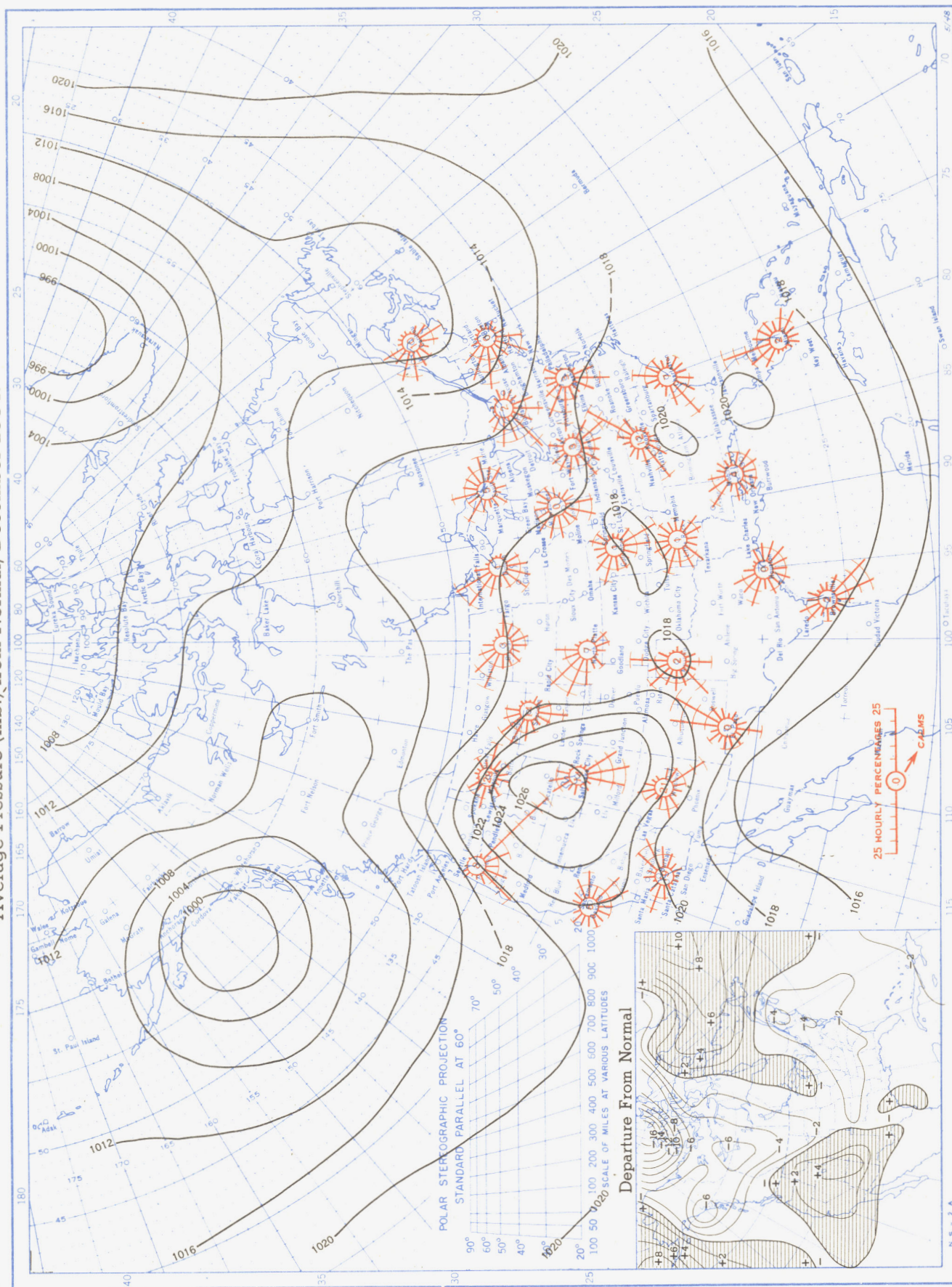


Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, December 1954. Inset: Departure of Average Pressure (mb.) from Normal, December 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

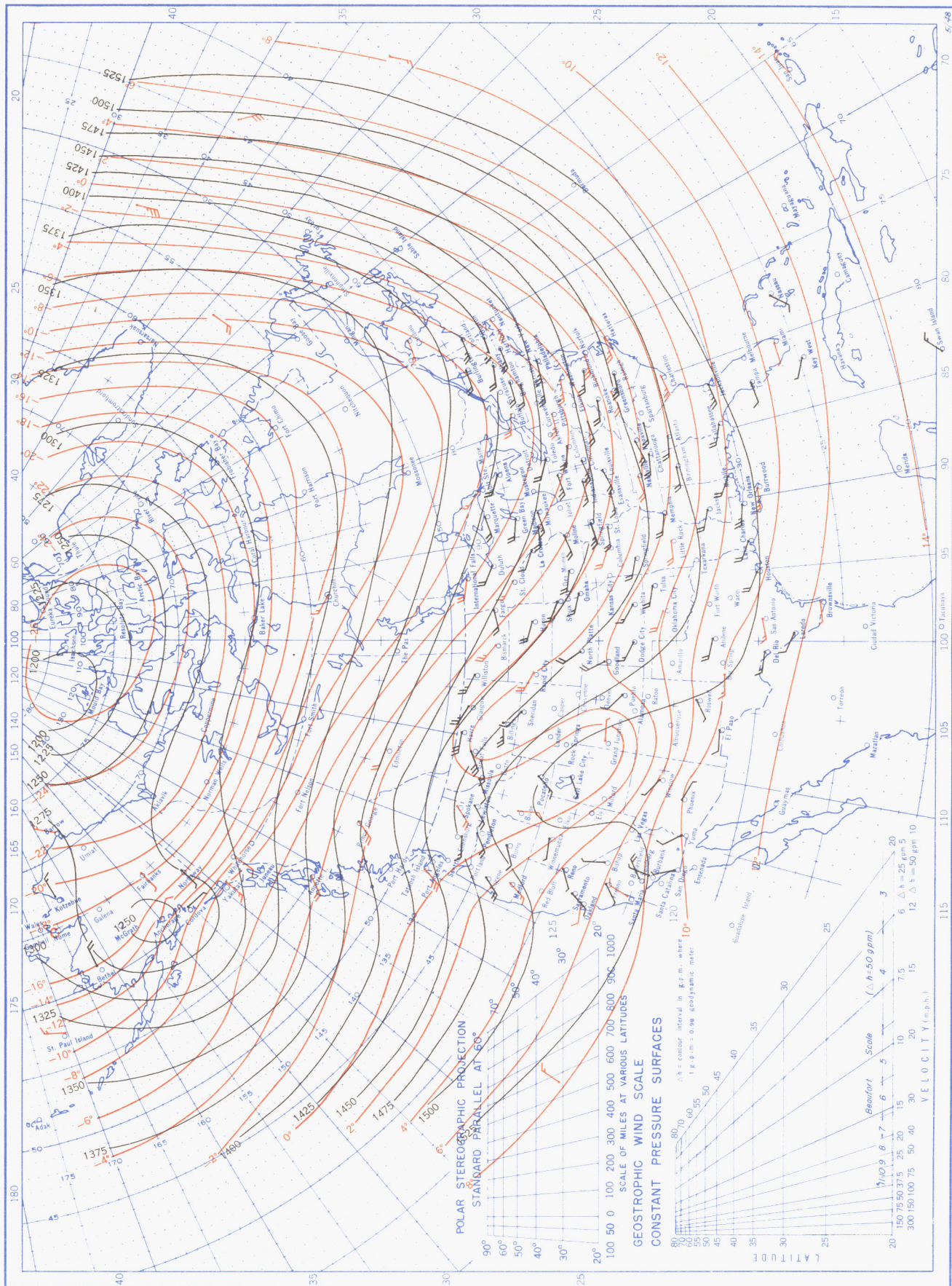


Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), December 1954.

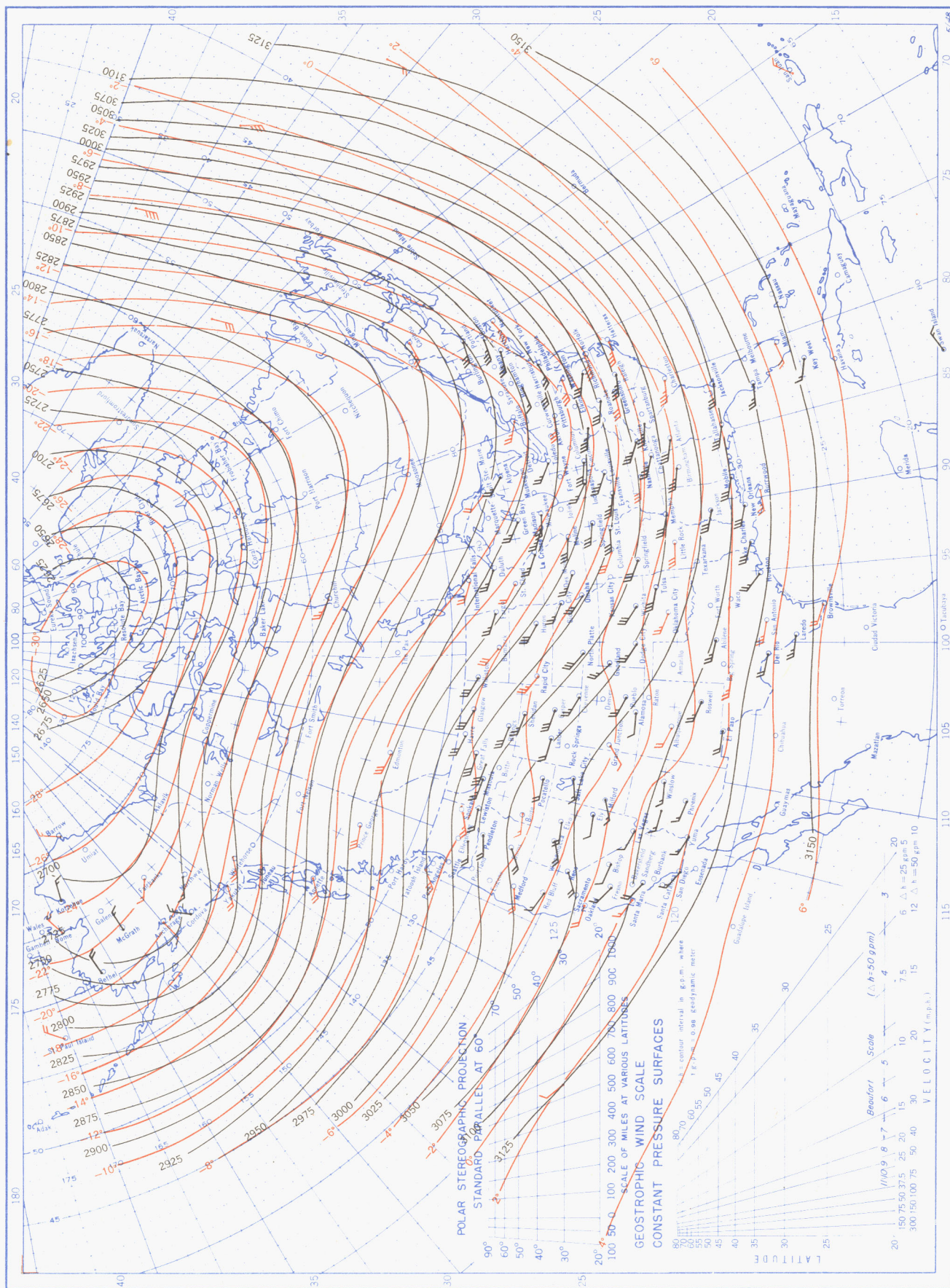
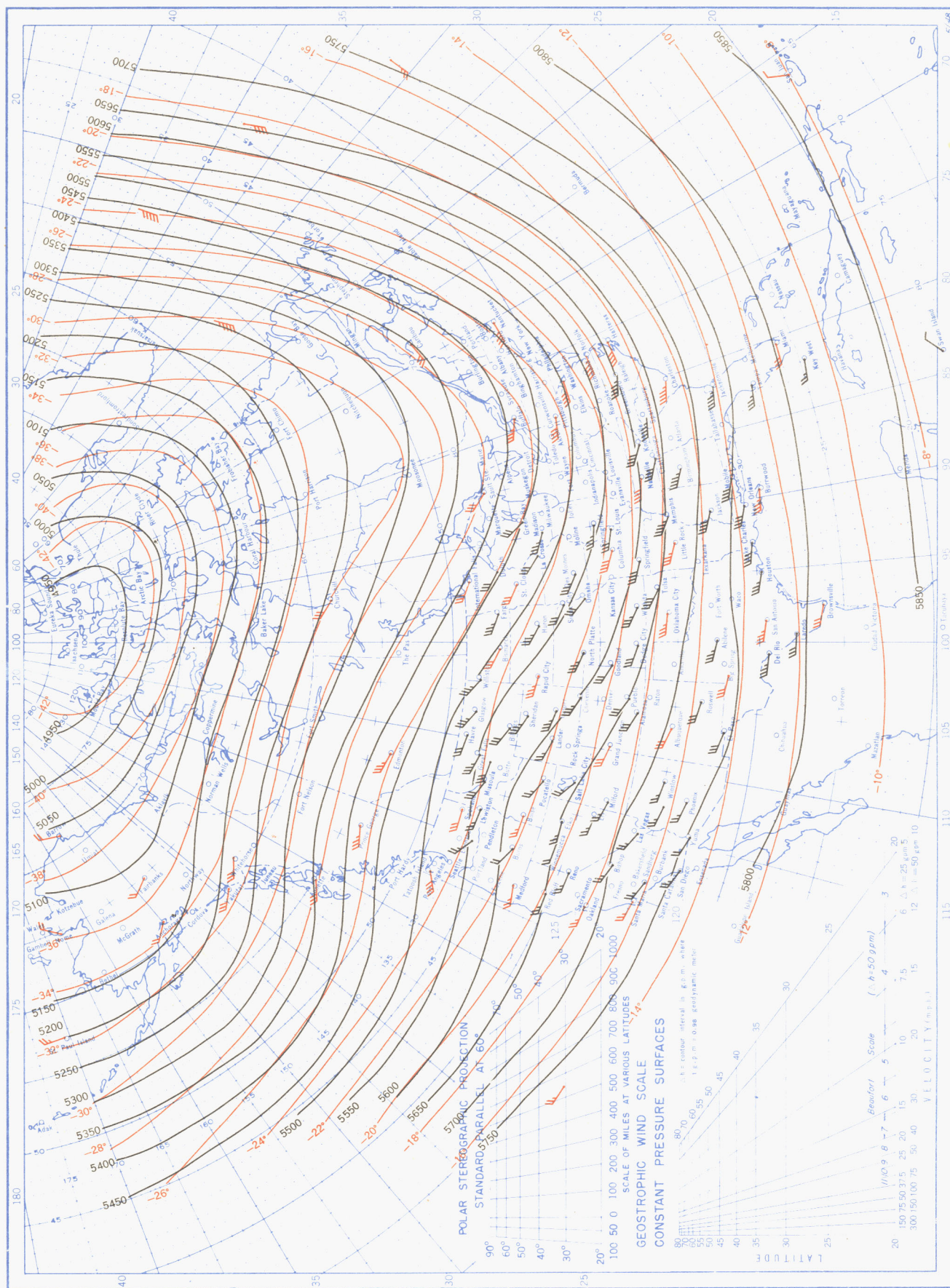
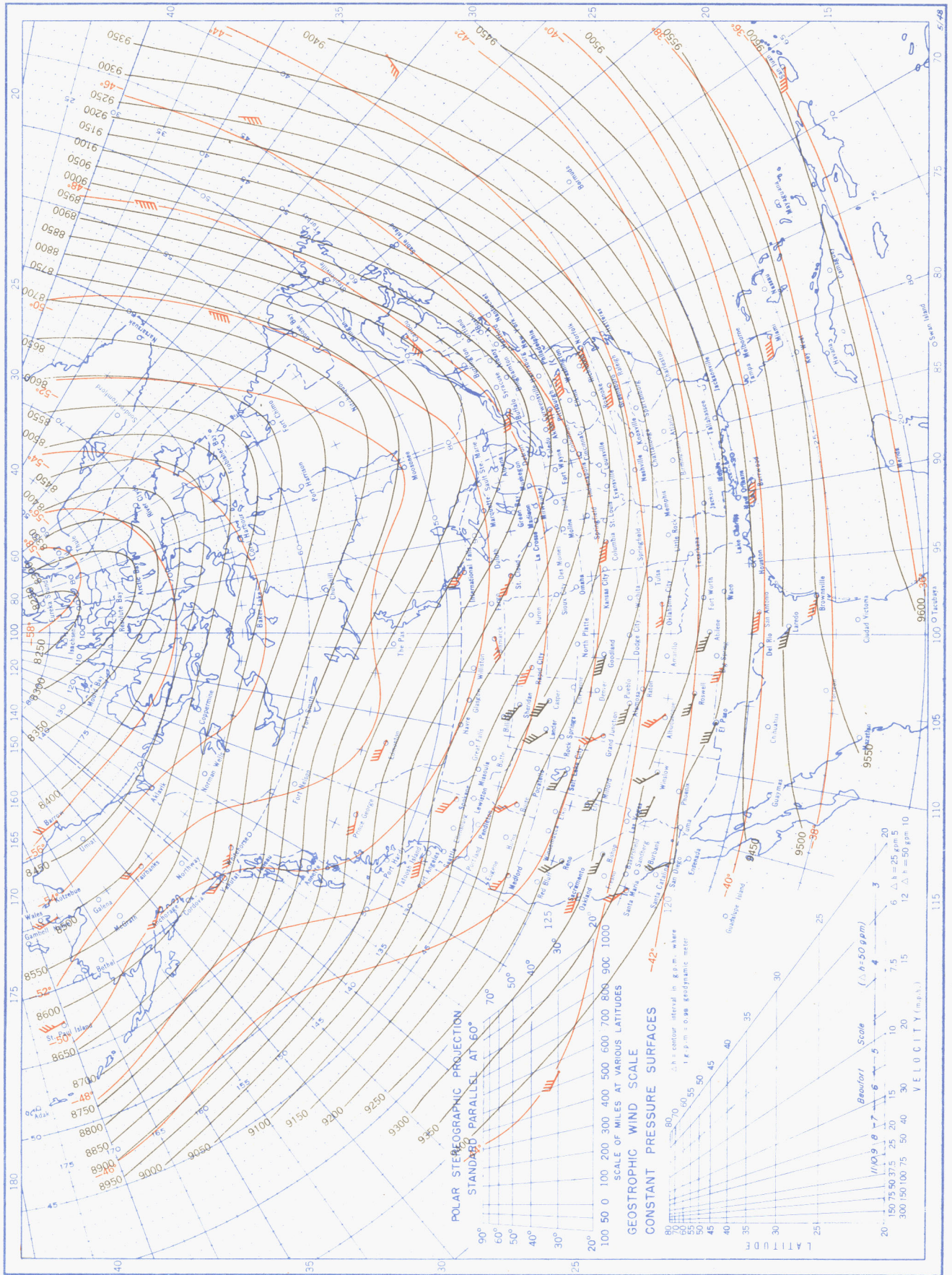


Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), December 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), December 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.